Sea Ice Outlook 2014, July contribution

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Type of prediction: statistical (initialized with June 30 sea ice extent)

Prediction: 4.52 +/- 0.49 million km^2

Summary of method:

Statistical method that uses an average of daily observed extent change rates to calculate a projected trajectory of daily extents for July through September. Daily extents from September are average to calculate the submitted monthly estimate.

Executive Summary:

This method uses daily extent change rates to project the 2014 extent on June 30 through the end of September. The daily September extents are averaged to create monthly averages. The prediction uses the years 2007-2013 as the basis for the extent, as more rapid recent rates likely better reflect the potential trajectory of this year's decline. This results in a projection of 4.52 million km^2 with a range of 0.49 million km^2, based on the standard deviation of the extent rates. A record low is deemed to be highly unlikely.

Overview:

Daily sea ice extent data are used to calculate daily change rates for each year in the satellite record (1979-2013). These daily change rates are then sequentially added to the June 30, 2014 extent data, producing simulated 2014 trajectories through September based on each of the previous years.

Rates have been faster in recent years, thus 2007-2013 values are used to calculate the Outlook value, as these are more likely reflective of current conditions. This yields a projection of 4.52 million km^2 with a range of 0.49 million km^2, based on the standard deviation of the extent rates. The lowest projection, based not surprisingly on 2012 rates, is 3.96 million km^2 (Figure 1). The highest projection since 2007 is from 2010 rates, 5.37 million km^2. The highest projection since 1979 is 6.03 million km^2, from 1980 rates.

For record minimum to be set, a seasonal decline unprecedented in the satellite record would need to occur. Thus, a record minimum this year is deemed to be highly unlikely. Similarly, no rates (even from the slowest years) yield a September extent near the 1981-2010 average of 6.52 million km^2.

Method:

For 1979 to 2013, daily extent change values are calculated for each day of the year based on the change in the extent between the previous day and the current day. For the Outlook, the June 30, 2014 sea ice extent is used as an initial condition. Then the daily extent change values for July 1 to September 30 are added sequentially to calculate simulated 2014 extents, as in the following equation.

$$Extent_{Day_n} = \sum_{1\ Jul}^{Day_n} \Delta Extent_{Day_n - Day_{n-1}}$$

This is done for each year, creating extent trajectories for July 1 to September 30, 2014, based on each previous year, yield 35 estimates of extent through July, August, and September. Trajectories from select years and average periods are shown in Figure 2. The daily September extents are then averaged to calculate the monthly September average.

Discussion:

The extent change rates vary from day to day, with periods of acceleration and deceleration. Some years, such as 2012 experience periods of rapid ice loss, while others have periods of slow or no loss. In addition, the timing of the daily minimum extent affects the September average. In some years, the minimum occurs early in September and then extent begins increasing, while in others the minimum occurs later in the month. The loss rates are affected by the synoptic weather conditions and the state of the sea ice. A thinner ice cover will experience greater loss under the same weather conditions because it is more easily melted completely. The rapidly changing Arctic sea ice, particularly over the past several years, makes projection difficult with this method, particularly so far from September. This is shown in the wide standard deviation range of nearly a half million square kilometers, even for the past seven low extent years (2007-2013). However, the method does provide an envelop of reasonably possible September extents. Closer to September, the envelop narrows as the range in extent rates narrows and the effect of different rates on the September extent is attenuated (due to fewer days for differences to accumulate). Thus, while perhaps not particularly useful (at least in terms of providing a forecast with usable error bars) at this stage, the method indicates the narrowing envelop of possible outcomes as September approaches.

Thus, the correct projection suggests that a record low September extent is highly unlikely and would require unprecedented rates of extent loss for the rest of the summer. However, such rates cannot be completely ruled out given the large changes in the ice cover over the years. For example, in 2012, a record was not seen as particularly likely (by this method) until a cyclone in early August greatly accelerated loss rates for several days.

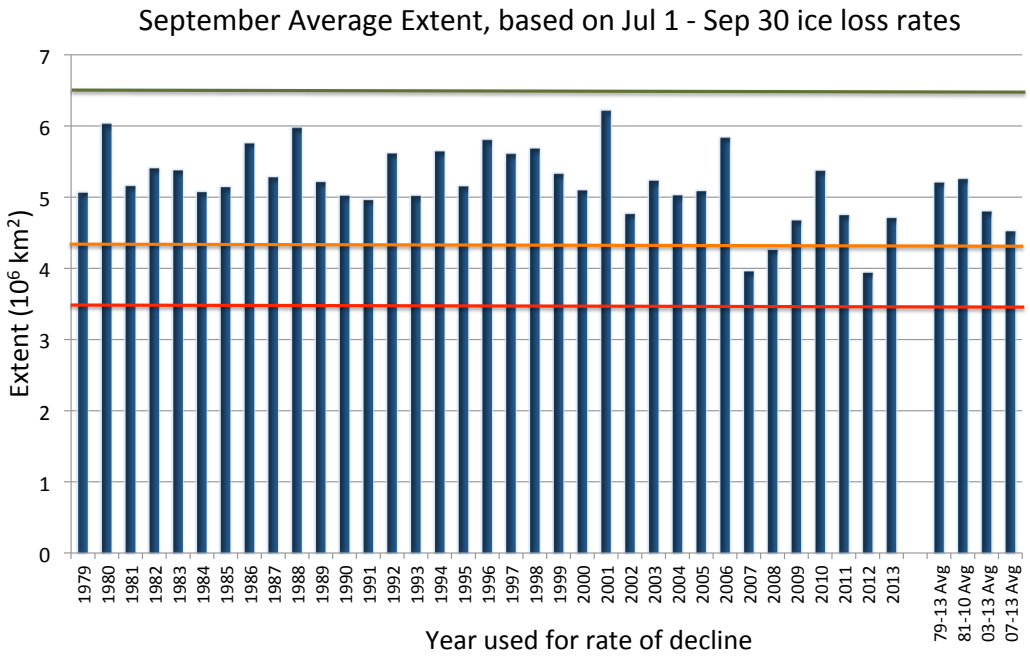

Figure 1. September average sea ice extent based on each year of extent decline rates and (on right) averages over different year ranges. The actual 1981-2010 average extent (green), 2007 extent (orange), and record low 2012 extent (red) are shown as straight lines.

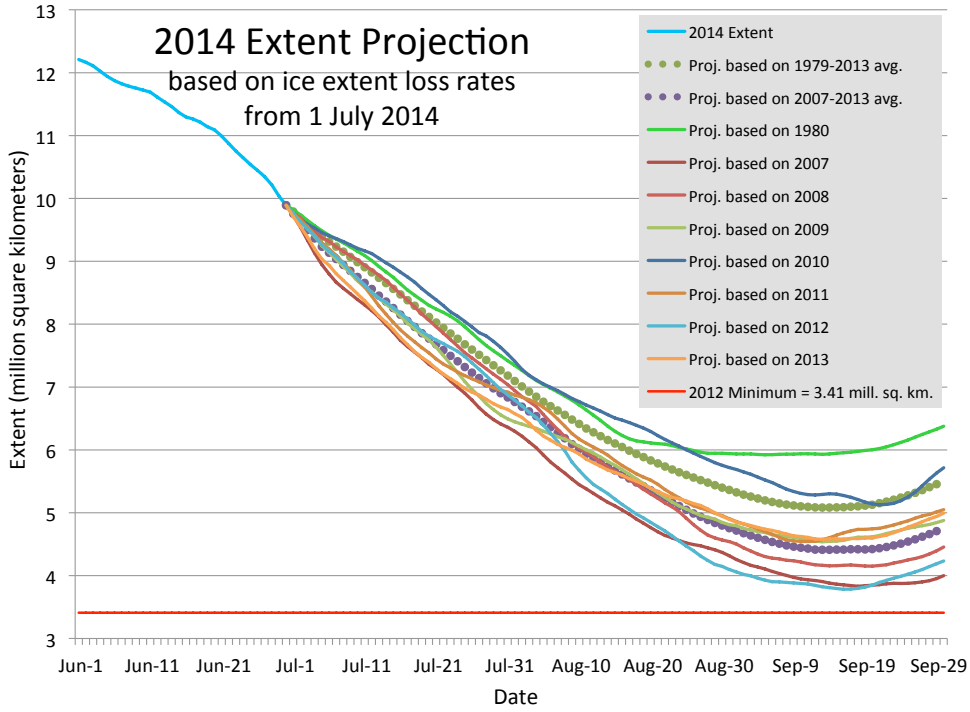

Figure 2. Trajectory of daily sea ice extent for 2014 based on selected years' decline rates, plus the 2012 record low daily extent (straight red line).